

SEASONAL HISTORY AND DISTRIBUTION OF *CARULASPIS MINIMA*  
(TARG.-TOZZ.) IN PENNSYLVANIA  
(HOMOPTERA: DIASPIDIDAE)

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*Abstract.*—The biology and distribution of the univoltine scale insect *Carulaspis minima* (Targ.-Tozz.) was studied at Harrisburg, Pennsylvania, during 1974-75 and its seasonal history compared to that of juniper scale, *C. juniperi* (Bouché). Fertilized adult females overwintered and began oviposition April 30 and May 23 of the two years studied. Eggs hatched in one week and peak crawler emergence occurred May 30 both years. Second instars appeared June 12, adult males and females, at the end of June. Adult males were most abundant the first two weeks of July, when they fertilized the females then died. The seasonal histories of *minima* and *juniperi* were similar. The distribution survey revealed that *C. minima* infests seven Pennsylvania counties, mainly in the southeastern portion of the state. The only hosts harboring *minima* during the survey were *Juniperus* spp. Natural enemies encountered during the study included the hymenopteran parasites *Aphytis* sp., *Aspidiotiphagus* sp., and *Prospaltella* sp., and the neuropteran predator *Aleuropteryx juniperi* Ohm.

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Two species of the genus *Carulaspis* MacGillivray are found in the United States: *Carulaspis juniperi* (Bouché), juniper scale, and *Carulaspis minima* (Targioni-Tozzetti), the so-called minute cypress scale. Both species are believed to be introduced, with Ferris (1937) stating that *juniperi* is European, and King (1902) suggesting *minima* to be Oriental. Both species are economically important. Naegele (1953) described severe damage to native junipers in Bermuda from exploding populations of juniper scale. In 1975 the number of quarantines levied against both scales on ornamental junipers in Pennsylvania was second only to the number imposed against black vine weevil on *Taxus*.<sup>1</sup> In 1958, *C. minima* was reported heavy on eastern red

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<sup>1</sup> From the nursery inspection records of the Bureau of Plant Industry, Pennsylvania Department of Agriculture, Harrisburg, Pennsylvania.

cedar, *Juniperus virginiana*, in Oklahoma (USDA, 1958). Recently, Dekle (1976) recognized that *minima* is economically important on juniper in Florida.

The first record of *C. minima* from the U.S. is King's (1902) collection on *Thuja* in Massachusetts. It has since been recorded from California, Florida, Georgia, Hawaii, Kansas, Louisiana, New Mexico, North Carolina, Oklahoma, Pennsylvania, Texas, Vermont, Virginia, and Washington. The identification of this scale in Pennsylvania (USDA, 1974) was made during the initial stages of a study of the arthropod fauna of ornamental juniper by Bureau of Plant Industry entomologists. I had been making preliminary observations on a population of scale thought to be *C. juniperi* but which I found to be *C. minima* with the aid of McKenzie's (1956) key. I began a more detailed investigation of *C. minima* because of the lack of published information on this species, probably the result of failure by workers to separate *minima* from *juniperi*. Also, a survey was initiated to determine its distribution and host range in Pennsylvania.

#### METHODS

An ornamental planting of *Juniperus chinensis* cv. 'Hetzii' on the grounds of the Pennsylvania Department of Agriculture, Harrisburg, Dauphin County, was selected. The planting, about 46 m long by 3 m wide, harbored a heavy infestation of *C. minima*. Weekly samples were taken from March through October 1974 and 1975. Each sample consisted of a randomly selected, scale-infested 15-cm terminal which was cut from the host plant and taken to the laboratory. The first 100 living scale forms encountered (including eggs) were removed from the host material, mounted five at a time on microscope slides in Hoyer's medium, and examined through a phase-contrast microscope to determine the stage of each specimen. The stage and sex (except first instars, which were not sexed) of nearly 4,500 specimens were recorded, and the percentage of each stage in the total sample was calculated.

Counts of deposited eggs were made by lifting the coverings of adult females and counting the eggs beneath. Most females carried additional undeposited eggs, and these were counted when the slide-mounted specimens were examined under phase-contrast. No attempt was made to determine total fecundity of the females since empty chorions were not counted.

Male scales and parasites were collected by the mailing tube and glass vial method described by Stoetzel and Davidson (1971). These were labeled and preserved in 70% ethyl alcohol in 2-dram vials.

Field observations were in themselves unsatisfactory for determining the number of annual generations. Overwintering females oviposited over a long period, a fact which would obscure oviposition by first generation females, should it occur. The number of generations was determined by transferring

active first generation crawlers to scale-free hetz junipers (potted 10-inch plants). After these had settled and matured (to first generation adults), they were observed periodically in order to detect any subsequent oviposition, which would indicate the onset of a second generation. The absence of such oviposition would suggest that the first generation adults overwinter.

The distribution survey for the two *Carulaspis* spp. in Pennsylvania utilized Bureau of Plant Industry inspectors, entomologists, and the author. Small clippings from *Juniperus* and *Thuja* plantings harboring what appeared to be juniper scale were taken and delivered to the laboratory in Harrisburg, where specimens were mounted on slides for identification.

To compare the seasonal history of *C. minima* with that of *C. juniperi*, a nearby population of *C. juniperi* on *J. chinensis* cv. 'Hetzii' from Camp Hill, Cumberland County, was monitored weekly during 1975. Approximately 20 specimens per week were mounted on slides in Hoyer's medium for phase-contrast studies.

### SEASONAL HISTORY

#### Fig. 1

*Carulaspis minima* is a univoltine species which overwinters as fertilized adult females. In southcentral Pennsylvania, the females began to swell in late March, and eggs could be seen in the bodies of slide-mounted specimens in the middle of April. Oviposition began April 30 in 1974 and May 23 in 1975, and peak oviposition occurred around the third week of May both years. Deposited eggs averaged 20 per individual, but the total number of eggs probably was more than 35 since slide-mounted females contained an average of 15 undeposited eggs, and empty chorions were uncounted. Most eggs hatched in seven days, although the incubation period ranged from five to eight days.

As the first-instar scales hatched, they emerged from beneath the parent scales and searched for suitable feeding sites. The crawlers settled in a short time (no crawlers survived more than 24 hours without feeding), inserted their mouthparts to feed, and became permanently attached to the host. This was the "settled crawler" or immobile phase of the first instar. Peak crawler emergence occurred around May 30 both years.

Second instars of both sexes began to appear in the samples June 12, two weeks after appearance of active and settled crawlers. The second stadium lasted about two weeks, during which both sexes had developed pygidia. Females attained a turbinate shape with no evidence of eyes, while males became elongate and developed easily visible eyespots. Incorporation of wax secretions into the scale cover began during the second stadium, and seemed to follow that described for *C. juniperi* by Stoetzel (1976). Female scale covers were usually smooth and circular, while male covers were

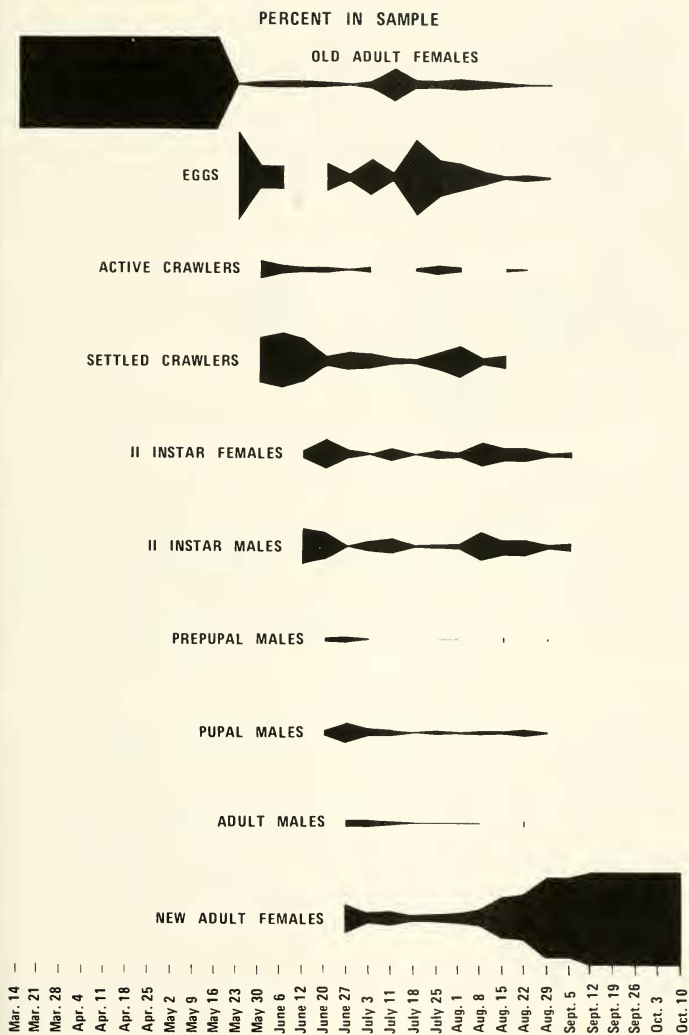


Fig. 1. Seasonal history of *Carulaspis minima* in 1975.

elongate and faintly tricarinate. The male covering was completed during the second instar.

First generation ("new") adult females appeared at the end of June, two weeks after the appearance of second instars. They differed from the second instars by the presence of a vulva surrounded by five clusters of perivulvar pores. New adult females were differentiated from old (overwintering) adult females by the absence of internally developing eggs, and they often had the mouthparts still in the crumena or coiled ready to descend into the crumena. This first generation overwintered and produced the following year's eggs.

Prepupal males were found one week after the appearance of second instars, about June 20. The prepupal period was short and did not last more than several hours. The pupal period (pupae were found in the same week's sample as the prepupae) lasted about a week. Neither prepupae nor pupae had functional mouthparts.

The emergence of the adult males began at the end of June and coincided perfectly with the maturation of the new adult females. Males immediately began to search out and fertilize the virgin females by wandering about and probing beneath the scale covers with their long genitalia. Laboratory observations of newly emerged males showed that they were short-lived. All lived at least eight hours, but none survived more than 40 hours. High numbers of males were present the first two weeks of July. After mid-July their numbers dropped quickly, but a small percentage of males could be found in the weekly samples until the middle of August. After late August, the population consisted primarily of fertilized adult females.

#### HOSTS AND DISTRIBUTION IN PENNSYLVANIA

In Pennsylvania *C. minima* was found only on *Juniperus* spp. with *J. chinensis* cv. 'Hetzii' the most common host (Table 1). Only *C. juniperi* was collected on *Thuja* and *Chamaecyparis*.

Of 165 scale samples collected in the distribution study only 16 contained *C. minima*. It was found mainly in the southeastern portion of the state and was present in only seven counties: Berks, Blair, Bucks, Cumberland, Dauphin, Snyder, and York (Fig. 2). Infestations of *C. minima* were most frequently encountered in the Cumberland-Dauphin-York county area.

#### NATURAL ENEMIES

Three parasitic species were encountered during the sampling. Two, *Aspidiotiphagus* sp. and *Prospaltella* sp., were internal parasites, feeding entirely within the female scale. At death the scales seemed to mummify, and the parasites' pupae could clearly be seen inside the derm of the scales. The third, *Aphytis* sp., fed externally on adult females (beneath the scale cover). Rate of parasitism by all species was low, reaching a maximum of 18% in

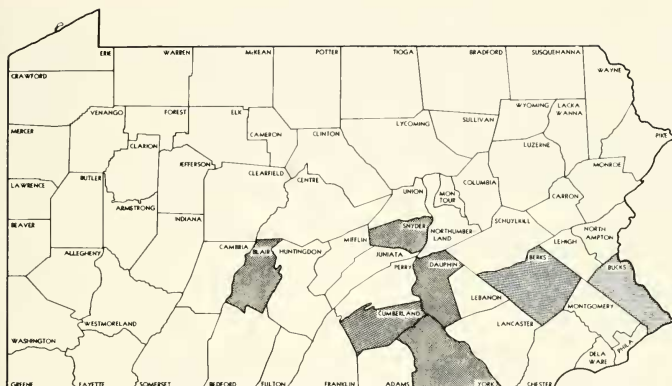


Fig. 2. Distribution of *Carulaspis minima* in Pennsylvania.

mid-July. Parasites were present from mid-May to mid-September, although no dramatic parasite emergence periods were observed.

*Aleuropteryx juniperi* Ohm, an introduced coniopterygid first reported from North America by Henry (1976), proved to be an important predator of *C. minima*. Both adults and larvae fed on all stages of the scale. This species reduced the scale population more than any other natural enemy in the experimental planting.<sup>2</sup>

## DISCUSSION

Field and laboratory observations indicate that *C. minima* is a univoltine species in Pennsylvania, although Baccetti (1960) report *C. minima* to have two generations per year in Italy. Scale transfer studies showed that only about 2% of the new females oviposited late in the summer. None of the progeny of this late oviposition survived the winters since no forms other than adult females were found in the early spring. Johnson and Lyon (1976) stated that adult males are active during late summer and fall. I found that by far the greatest percentage of males emerged during the first two weeks of July, and only small numbers were present into late summer. No adult males of either species were found in the samples after August 22. Comparison of the life histories of these two species showed them to be similar,

<sup>2</sup> Personal communication, T. J. Henry, Bureau of Plant Industry, Pennsylvania Department of Agriculture, Harrisburg, Pennsylvania.

Table 1. Numbers of collections of *Carulaspis juniperi* and *C. minima* taken from various hosts in Pennsylvania, 1974-75.

Host	<i>Carulaspis minima</i>	<i>Carulaspis juniperi</i>
<i>Chamaecyparis</i> sp.	0	1
<i>Juniperus chinensis</i>	2	35
<i>J. chinensis</i> cv. 'Hetzii'	5	43
<i>J. chinensis</i> cv. 'Pfitzeriana'	1	30
<i>Juniperus communis</i>	1	3
<i>Juniperus excelsa</i>	1	3
<i>Juniperus horizontalis</i> cv. 'Plumosa'	1	1
<i>Juniperus procumbens</i>	0	1
<i>Juniperus scopulorum</i>	0	1
<i>Juniperus virginiana</i>	1	9
<i>Juniperus</i> sp.	4	16
<i>Thuja occidentalis</i>	0	6

as hatching dates, growth rates, and adult emergence dates were nearly identical. This disagrees with Boratynski (1957) who found that in Britain the seasonal history of *C. minima* lagged up to two weeks behind that of *C. juniperi*. Both species developed later in Britain than in Pennsylvania; *C. juniperi* and *C. minima* developed two and four weeks later, respectively, in Britain than my studies indicate for Pennsylvania. Baccetti's studies of *C. juniperi* in Italy show only one generation per year.

The crawlers of *C. minima* normally settled away from the parent scale, so infestations were only one layer thick and did not build up to a multilayered crust as do some armored scales, such as obscure scale, *Melanaspis obscura* (Comstock) (Stoetzel and Davidson, 1971). During the 2-year sampling period the scales infested only the lower portions of the hosts and populations did not move upward significantly. This suggests that *C. minima* crawlers do not move great distances and have a limited ability to disperse upward, except when branches are touching.

In Pennsylvania *C. minima* was found only on *Juniperus*, although McKenzie (1956) lists these additional hosts: cypresspine, *Callitris articulata*; cypress, *Cupressus* sp.; redwood, *Sequoia sempervirens*; and arbovitae, *Thuja* spp. Johnson and Lyon (1976) seemed to suggest that *C. minima* is restricted to *Thuja*, with no mention of any additional hosts. Workers should not attempt to separate the two species solely by host information, since both species apparently attack *Juniperus* and *Thuja*.

*Carulaspis minima* is probably more common than previously thought because of the difficulty in separating it from *C. juniperi*. I am certain that additional sampling in Pennsylvania and other states would prove that the range of *C. minima* is greater than previously indicated.

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